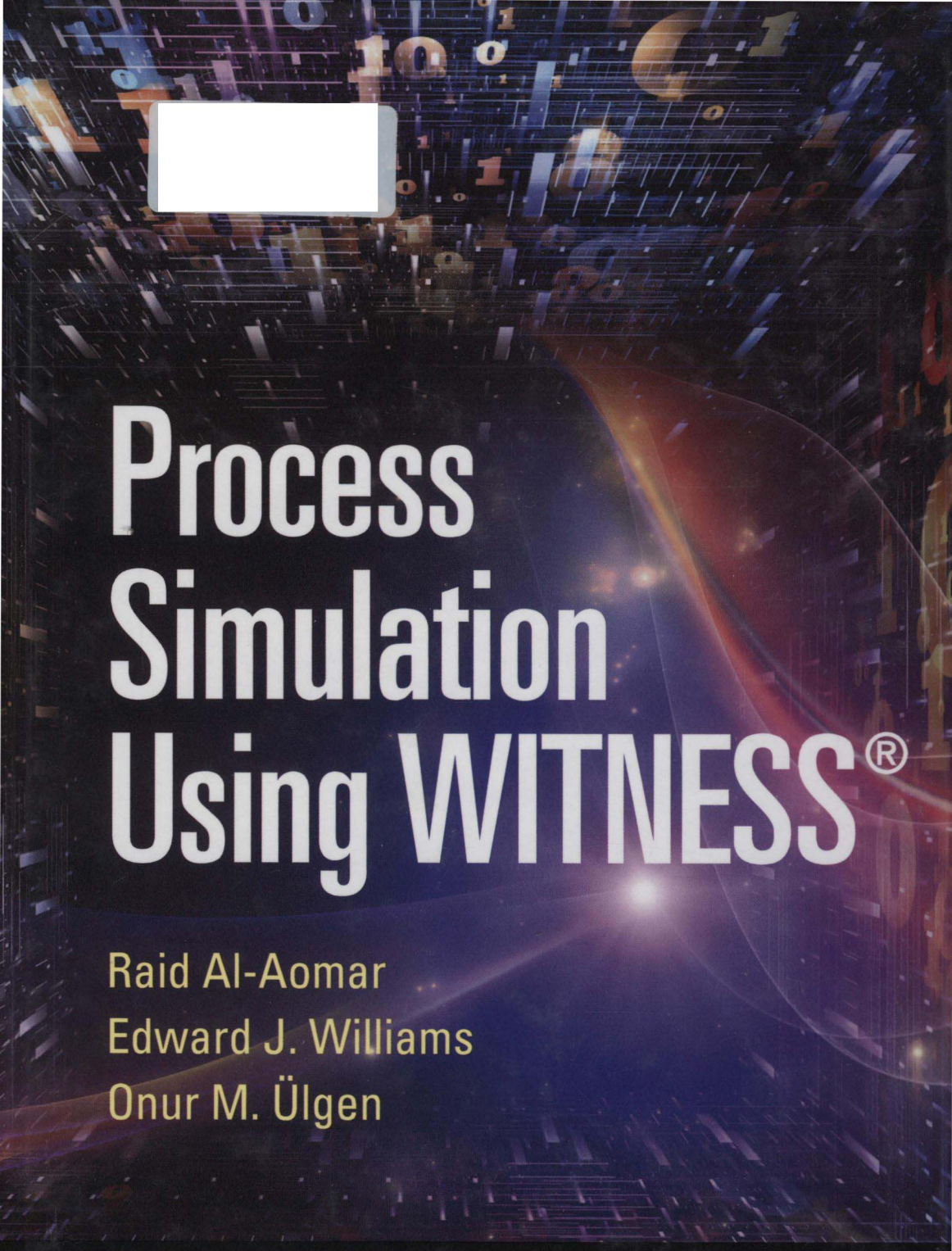

Process Simulation Using WITNESS®

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WILEY

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PROCESS SIMULATION USING WITNESS®

"To Ferial, Salma, Saja, Yaman, and Kenan."

—Raid Al-Aomar

"To Ravi and Marcelo."

—Edward J. Williams

"To My Parents and İdil, Berkin and Cenk."

—Onur M. Ülgen.

ABOUT THE COMPANION WEBSITE

This book is accompanied by a companion website:

www.wiley.com/go/processsimulationusingwitness

The website includes the following:

- Presentation slides for each chapter
- WITNESS® software download
- Camtasia audiovisual files of building models

PREFACE

Routine use of simulation to improve processes is rapidly approaching the half-century mark. Initially, simulation (and, in particular, discrete-event process simulation, the topic of this book) was most frequently applied to manufacturing operations. In the last several decades, simulation analyses have expanded broadly, and interestingly, into niches such as warehousing, logistics, supply-chain operations, health care, harbor and maritime operations, mining, hotel and restaurant management, and more. Concurrent with this expansion of simulation and its usage, software dedicated to simulation has steadily expanded from languages (e.g., SIMAN®, SIMSCRIPT, GPSS) to free-standing software packages (e.g., WITNESS®, SIMUL8®, ProModel®, AutoMod®). These simulation packages now interface readily with spreadsheets, databases, and statistical software. Furthermore, they support two- and three-dimensional animations built concurrently with building a simulation model, along with integrated modules for optimization and experimental design. WITNESS®, a powerful, easy-to-use package and hence a worthy competitor, is explained in this text.

Effective use of simulation has foundations much deeper than facility in using any one software tool. These foundations include understanding of how a simulation model attempts to accurately reflect the operation of a real system through time; therefore, a simulation model provides a behavioral dynamic movie, not just a snapshot, of the system it represents. The accuracy of this representation requires understanding of statistical concepts such as randomness, choice of statistical distributions, independence, correlation and autocorrelation, the importance of sample size, and the building of confidence intervals. This understanding is necessary to support the analyst's decisions concerning whether to use a steady-state or terminating model analysis, choice of simulation run length, and choice of the number of replications.

This book is intended for use either within a university discrete-event process simulation course (advanced undergraduate or graduate level) or for self-study to learn the concepts of simulation and the use of the WITNESS® simulation software. Accordingly, most chapters provide exercises for the reader and student. Uniquely among such books, it provides exposition of all of the following:

- Role of simulation in Six Sigma projects.
- Role of simulation in Lean Systems.
- Simulation-based optimization.
- Case studies in manufacturing.
- Case studies in service industries.
- Use of WITNESS® as a simulation environment.
- Project management in the context of simulation projects.
- Examples in each chapter on the methods and concepts presented.

The organization of the book is as follows:

Chapter 1 explains the concepts of simulation modeling, with emphasis on discrete-event (as opposed to continuous) modeling.

Chapter 2 compares and contrasts the various world views, and hence conceptual approaches, available to the simulation modeler.

Chapter 3 provides an overview and a "guided tour" of the WITNESS® modeling environment.

Chapter 4 covers basic WITNESS® modeling techniques; after studying this chapter, the reader or student will be able to build simple WITNESS® models.

Chapter 5 covers the modeling of material handling systems, introducing the powerful WITNESS® concepts of Paths, Conveyors, Vehicles, and Tracks.

Chapter 6 provides a rigorous statistical overview of the concepts whose understanding is necessary for accurate analysis of both model inputs and model outputs. Fundamental concepts reviewed and explained here include random variables (both discrete and continuous), point estimation, and estimation by construction of confidence intervals. The importance of sample size to estimation is emphasized.

Chapter 7 uses these concepts to cover simulation model input analysis in detail, including the importance and techniques of fitting closed-form distributions to observed data. This chapter also provides "checklists" of frequently and routinely needed input data in various contexts.

Chapter 8 covers simulation model output analysis extensively, including the distinction between terminating and steady-state models, point and interval estimation, experimental designs such as full and fractional factorial, and hypothesis testing.

Chapter 9 then shows how to use these techniques and others to undertake simulation model verification (does the model work as the modeler intends?) and validation (does the model accurately reflect the behavior of the real or proposed system?).

Chapter 10 discusses effective techniques for managing a simulation project; these techniques require clear communication among modelers, statistical analysts, engineers, and managers. The eight major phases of a properly managed and executed simulation project, and their interrelationships, are explained here.

Chapter 11 provides case studies exemplifying the use of simulation in manufacturing. When applied to manufacturing, simulation analyses help assess vitally important performance metrics such as JPH (jobs per hour), waiting times (both average and extreme), queue lengths (average and extreme relative to buffer capacities), and effects of downtime. One of these was undertaken at an automotive supply company, another at an aviation company, and yet another at a pipe manufacturing company.

Chapter 12 likewise provides case studies concerning the use of simulation in service industries. Service industries to which simulation has been vigorously applied include banking, food industry (both food markets and restaurants), health-care systems (doctors' and dentists' offices, clinics, and hospitals), telecommunication, transportation, and the insurance industry. The examples in this chapter include a car wash, an oil-tanker port, and a bank.

Chapter 13 discusses simulation-based optimization methods. The contributions which methods such as gradient estimation, random search, and tabu search can make to a simulation-based analysis are explained and compared. This chapter also presents more statistically based methods of seeking optima, such as design of experiments (DOE) and response surface methodology (RSM).

Chapter 14 discusses the use of simulation to build and enhance lean systems, explaining how it can help enhance performance metrics such as reducing the various wastes such as excess inventory, non-value-added motion, and idle time.

Chapter 15 discusses the interrelationships and synergy between simulation and Six Sigma. In particular, simulation analyses can identify and evaluate strategies for reduction of variability (e.g., in processing times and transit times); this reduction of variability is a central component of Six Sigma.

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